

PROVIDING SMOOTH,
STEPLESS
ACCELERATION, SOFT
STARTERS FILL GAP
BETWEEN FULL
VOLTAGE STARTING
AND INVERTERS

Soft starters *avoid hard knocks controlling ac motors*

CURTIS LITTEN, PRODUCT SPECIALIST/APPLICATIONS ENGINEER,
T.B. WOOD'S, CHAMBERSBURG, PA

Soft start's strengths

1. Can be used in non-reversing and reversing applications
2. Can be easily reconfigured
3. Solid state starter models include advance motor protection features, including underload, phase imbalance, and electronic shearpin
4. Includes monitoring and diagnostics for motor and control protection against voltage spikes, over temperature, under voltage, or internal faults
5. Includes current limiting control for smoother accelerations
6. Includes slow-speed jogging capability for machine/process setup
7. Provides adjustable control of the acceleration ramp
8. Available in hp ranges from 3 to 200 hp at 230V ac, 3 to 1,200 hp at 460V ac, and 5 to 1,400 hp at 575V ac And much more...

The starting and controlling of an ac motor—cost-effectively—is no doubt among the great engineering challenges of the modern world. Soft starting, which bridges the gap between full voltage starting and inverters, may be just the solution today's engineers are looking for.

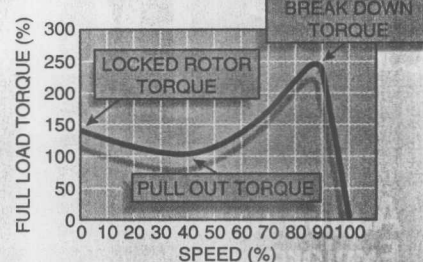
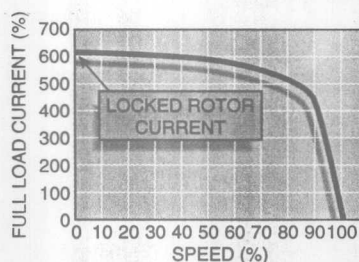
Most motors start quickly and effectively when full rated voltage is applied to them. This so-called "across-the-line" starting is the main approach for ac induction motors, through the use of an electro-mechanical contactor and overload device. This is known as a "starter."

Unfortunately, in many cases, this type

of starting is extremely inefficient, due in large part to the very high utility demand charges. To make matters worse, many utilities also impose restrictions on the size and number of motors that incorporate a full voltage start. These restrictions are not merely for the benefit of the utility—the disturbances created by across-the-line starting can induce problems on power lines in the vicinity.

Other disadvantages of across-the-line starting: the potential for voltage sags and shock damage to the power transmission line; surges caused by switching full voltage power to the motor, resulting in stress on the motor wiring and insulation; and jolting starts that can damage equip-

Torque/Speed/Current Relationships



A typical design B motor marries a good starting torque with an acceptable current draw.

ment and products.

The alternative to a full voltage start is some sort of acceleration control, called "soft starting." Interest in this area has been growing, particularly with today's focus on motor efficiency. In many regions of the country, local municipalities require that all new motor installations incorporate a means of soft starting the motor. The typical range for this requirement is between 75 and 200 hp. The Motor Efficiency Act, which went into effect in October 1997 and requires that all motors be at least 87% efficient, has also spurred interest.

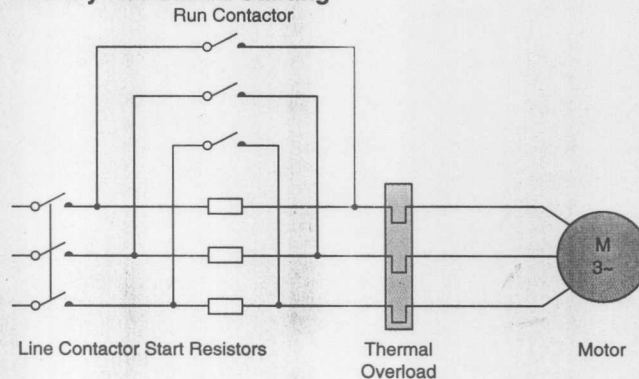
There are many different approaches to soft starting. The technique actually came into use many years ago, with the introduction of the primary resistance starter (see figure). It incorporates a resistor or series of resistors to the motor wiring to limit the voltage applied to the stator. With both voltage and current limited, the motor develops less torque, resulting in a lower rpm. Once the load is started, a RUN contactor is energized, shorting out the resistors. Full voltage brings the motor to its full rated speed.

Some of the disadvantages of primary resistance starting include: difficulty in changing the resistance; a limited number of starts per hour; difficulty in starting high inertia loads; and the fact that a large amount of heat is dissipated.

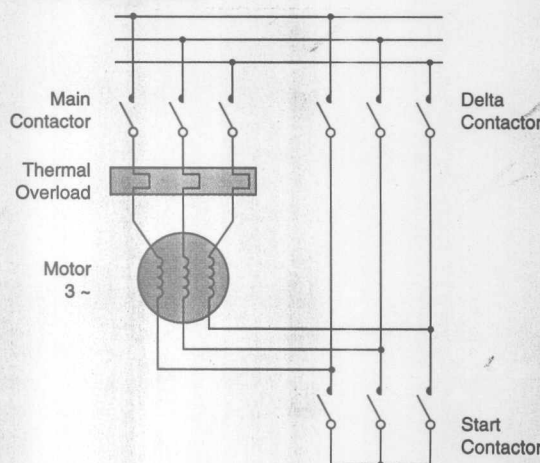
Another form of soft starters, auto transformers, uses a different approach to bring the motor to speed in a controlled manner. They use the windings of the transformer to provide a limited supply voltage to the motor for starting, then rely on a RUN contactor for normal full-speed operation (see figure). With weaknesses such as limited voltage taps, limited number of starts per hour, reduced torque at all speeds, and a high cost, the technology has had its difficulties in winning the outright confidence of consumers.

Yet another approach to soft starting is part-winding and Star-Delta (or Wye-Delta). Their "two-speed" operation provides the customer with a start winding and a RUN winding. A simple two-contactor starter selects the desired mode (see fig-

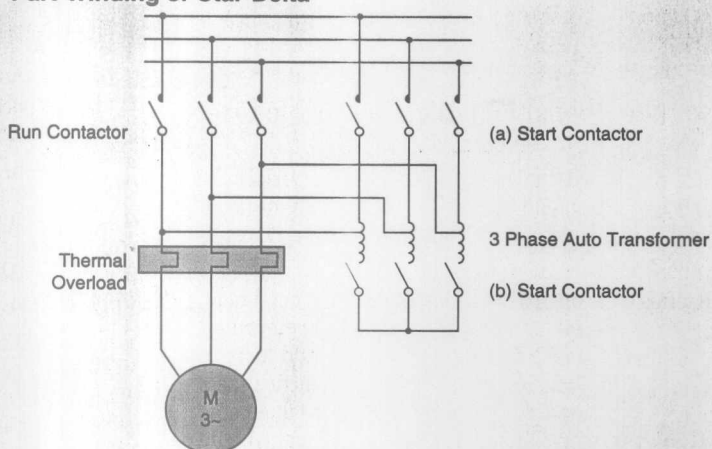
Soft Start Approach #1 Primary Resistance Starting

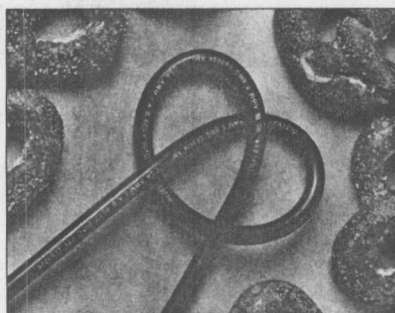


Soft Start Approach #2 Auto Transformer



Soft Start Approach #3 Part-Winding or Star-Delta



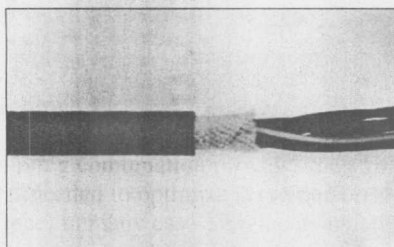


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ure). The amount of motor windings (stator) connected into the circuit provide full or limited starting capacities. On the downside, start torque cannot be adjusted and few loads actually accelerate to full speed in Star (Wye) connection. The use of open transition switching can also cause severe mechanical and current transients.

Beyond soft start technology, which starts the motor in a slow, controlled manner, a solid-state starter has the added capability of protecting the motor from an overload

condition. It provides this protection by either electromechanical or electronic means, as in the S-trAC HST and DST series Solid State Starters. Both models have fully programmable electronic overload protection that meets code requirements. The ability to program the HST allows it to bridge the gap between full voltage starting and inverters while maintaining the flexibility of the latter.

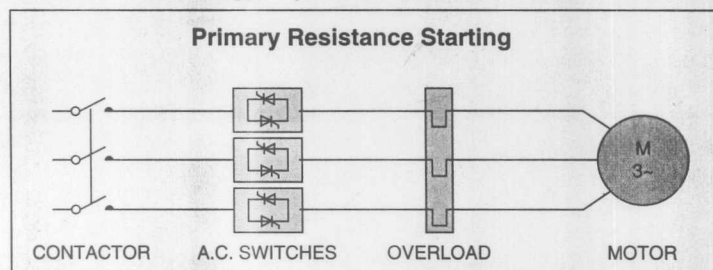
Advanced control features—either on a soft start or solid-state starter—provides even better protection for the motor. Some controls not only monitor current draw and motor temperature with an optional thermistor input, but also take into account the number of starts.

As the technology of soft starts has progressed, their flexibility has increased. There are as many different methods of accelerating the motor to full speed and providing motor protection as there are soft start suppliers.

The S-trAC series Soft Start Controllers provide various methods of acceleration. The HST series Solid State Starter provides two acceleration ramps. The constant current ramp applies a constant current to the motor, dynamically changing the applied voltage as the load varies. This method is especially effective in pumping applications to eliminate water hammer and instabilities found in some soft starting systems. The ramped current allows a fixed starting current to be set along with an adjustable acceleration time. This method is ideal for applications in which loads that easily break

away need longer start times or when the supply capacity is limited.

The DST models with the "kickstart" feature supply a large voltage peak at starting to provide the required torque, phasing the voltage back to a standard acceleration ramp. With current limit, the primary consideration is not necessarily a jolt-free start, but rather a start with



enough breakaway torque without damaging equipment or products.

Like all technologies, there are some things that a solid state starter cannot do. It cannot solve problems associated with a difficult starting load, requiring in some cases a larger motor or a motor with a different starting characteristics. A change to the overload class may be an option, but still may not be the solution.

But nevertheless, the soft start controller/solid state starter market has the potential to be fast-growing and highly-competitive. The starters provide smooth, stepless acceleration with no moving parts to wear out and require virtually no maintenance.

For more information

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